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Wilmot

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(54) **REAL-TIME DATABASE UPDATE TRANSACTION WITH DISCONNECTED RELATIONAL DATABASE CLIENTS**

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G06F 17/30 (2006.01)

(52) **U.S. Cl.** **707/201**; 707/10; 707/203

(58) **Field of Classification Search** 707/200–204, 707/10
See application file for complete search history.

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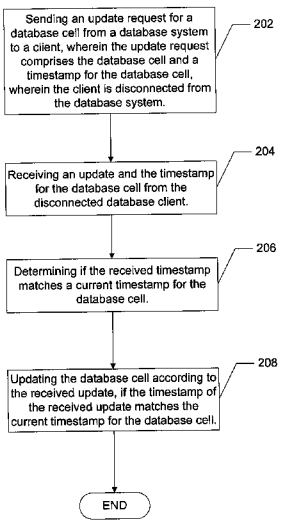
(57) **ABSTRACT**

A method and system for performing real-time database update transactions with disconnected database clients includes a disconnected client server (DCS) and disconnected client extensions (DCE). The DCS formats the database cell, its key, any associated database cells, and a timestamp and sends them to a disconnected database client by email. The timestamp indicates the last time the database cell or associated database cells was changed. The disconnected database client sends a reply email with the update of the database cell and the timestamp. Upon receipt of the reply email, the DCS compares the received timestamp to a current timestamp for the database cell. If they match, then the database cell is updated according to the received update. If they do not match, then the update is based on outdated information and is rejected. In this manner, reliable real-time update transactions are provided between a disconnected database client and the database.

6 Claims, 4 Drawing Sheets



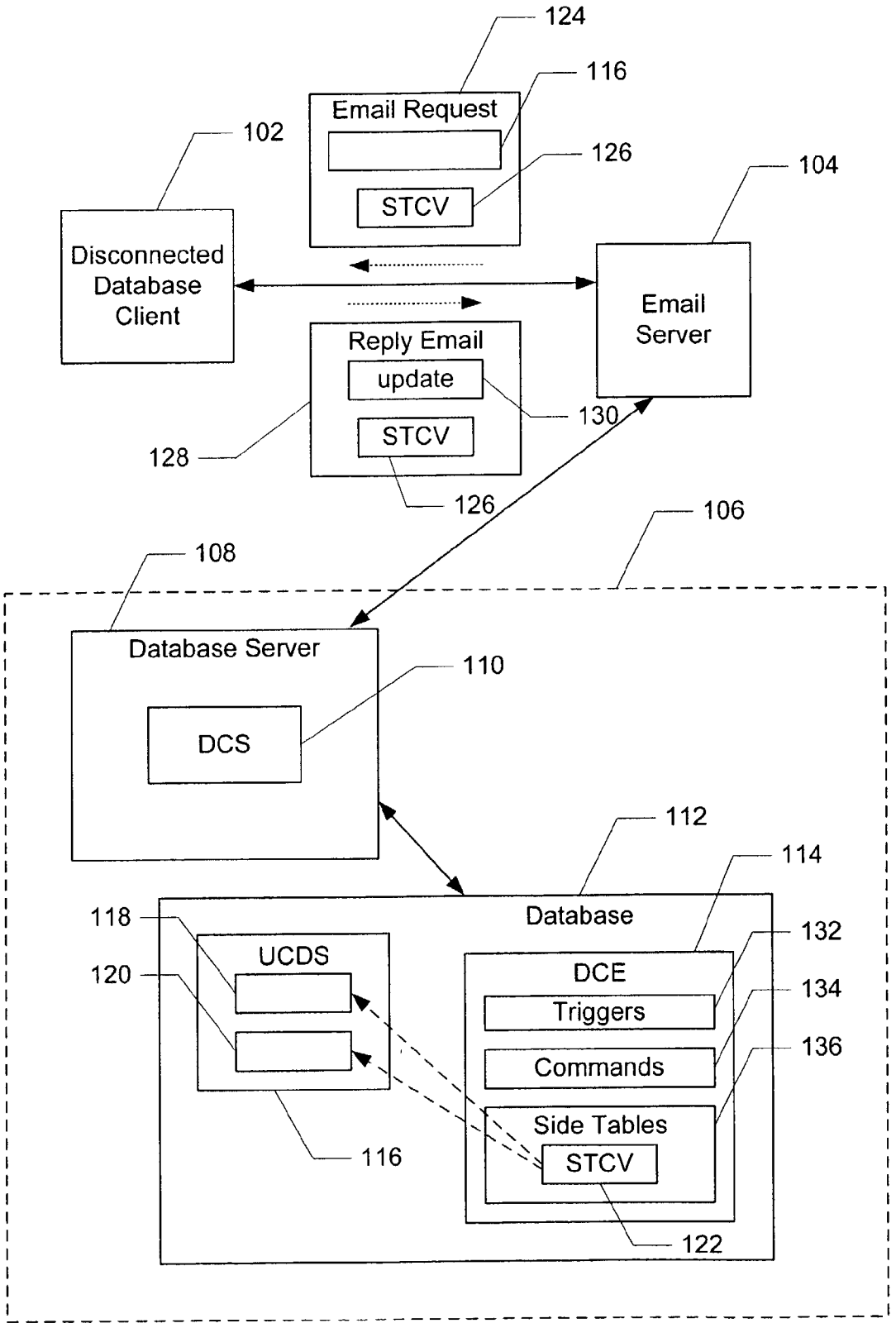

124
116
Email Request
102
126
104
STCV
Disconnected Database Client
Email Server
Reply Email
update
130
STCV
128
126
106
108
Database Server
110
DCS
112
114
118
Database
132
UCDS
120
DCE
134
Triggers
Commands
136
Side Tables
STCV
116
122

FIG. 1

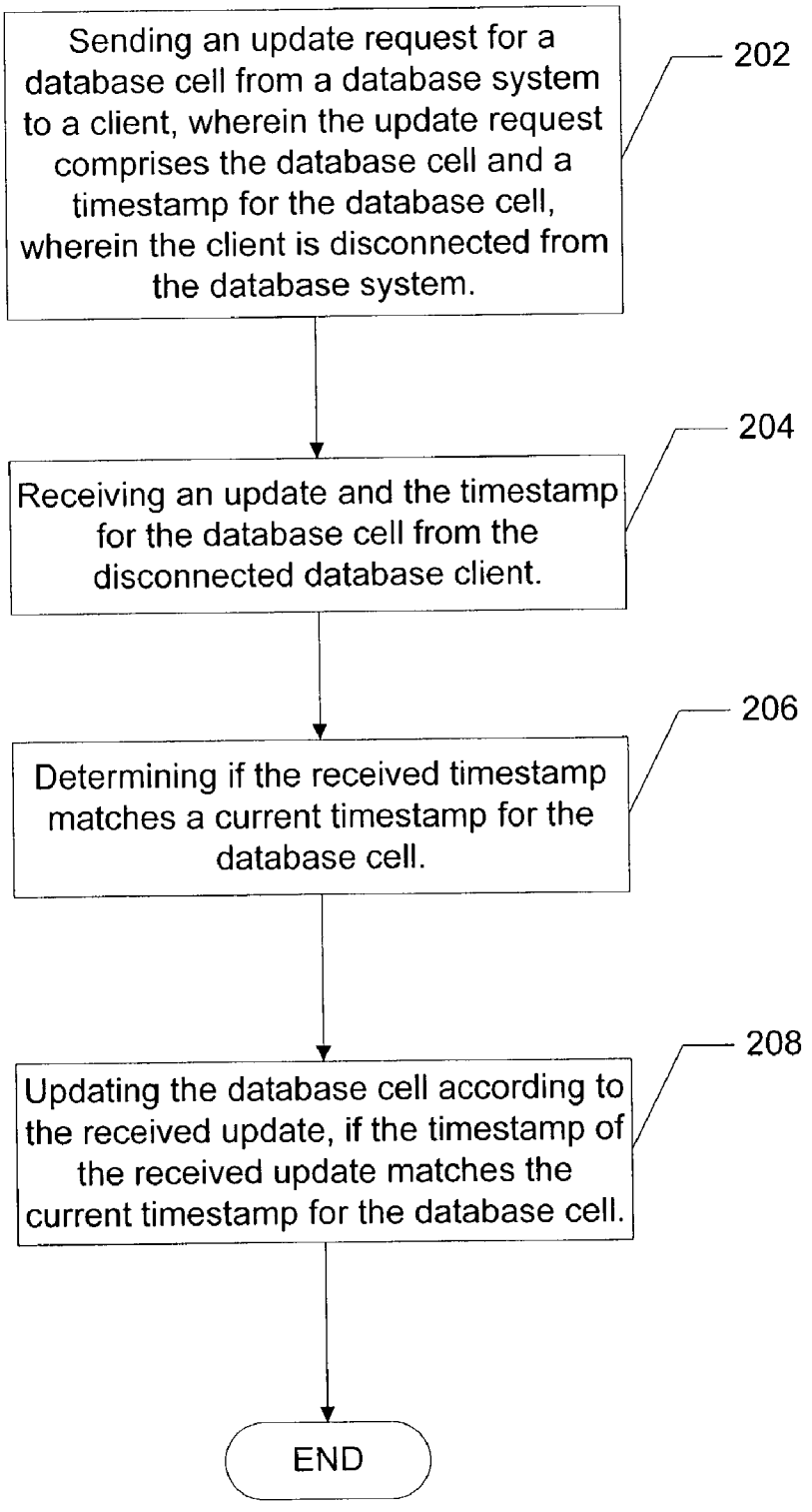

Sending an update request for a database cell from a database system to a client, wherein the update request comprises the database cell and a timestamp for the database cell, wherein the client is disconnected from the database system.
202
Receiving an update and the timestamp for the database cell from the disconnected database client.
204
Determining if the received timestamp matches a current timestamp for the database cell.
206
Updating the database cell according to the received update, if the timestamp of the received update matches the current timestamp for the database cell.
208
END

FIG. 2

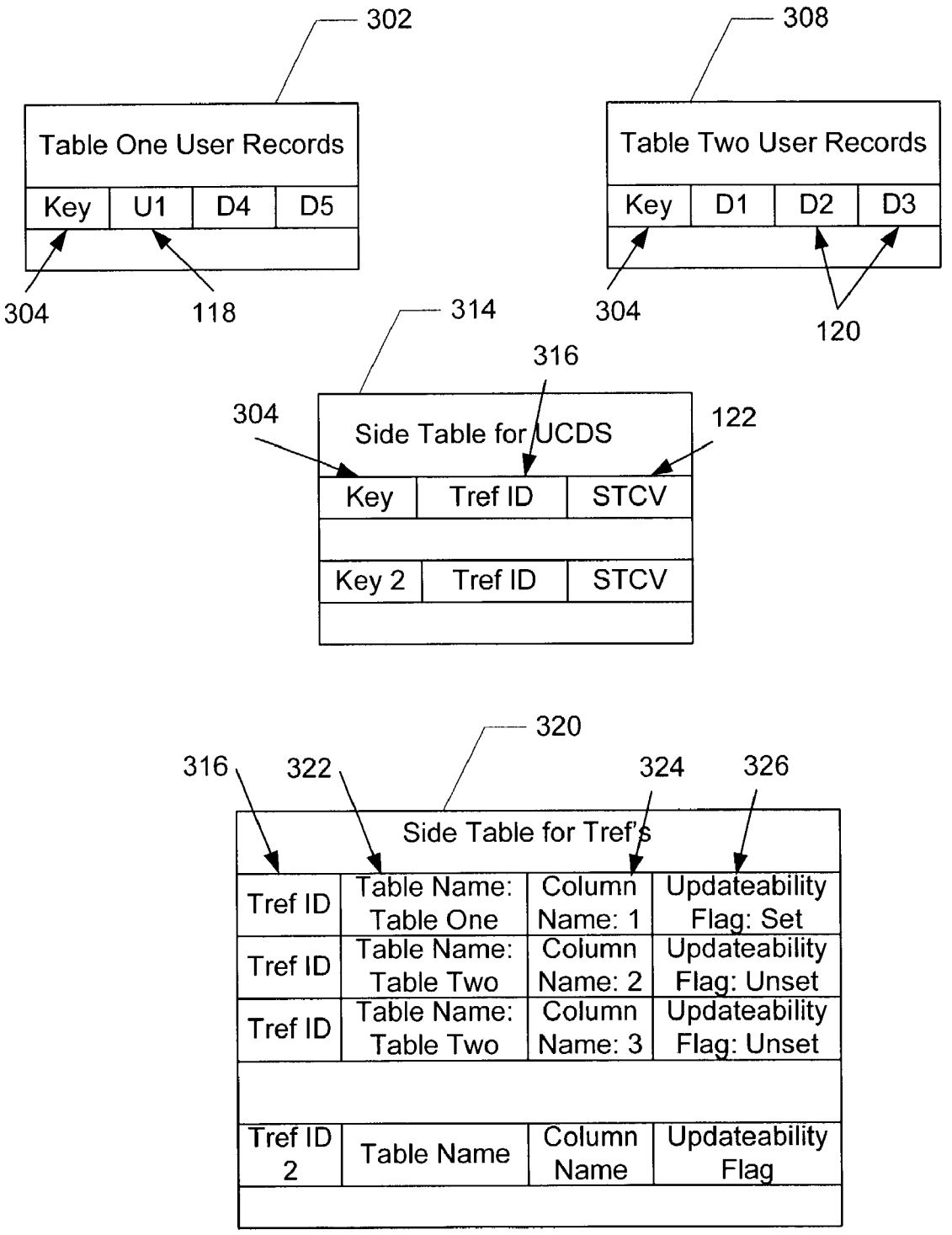

302
Table One User Records
Key
U1
D4
D5
304
118
308
Table Two User Records
Key
D1
D2
D3
304
120
314
316
304
Side Table for UCDS
122
Key
Tref ID
STCV
Key 2
Tref ID
STCV
320
316
322
324
326
Side Table for Tref's
Tref ID
Table Name: Table One
Column Name: 1
Updateability Flag: Set
Tref ID
Table Name: Table Two
Column Name: 2
Updateability Flag: Unset
Tref ID
Table Name: Table Two
Column Name: 3
Updateability Flag: Unset
Tref ID 2
Table Name
Column Name
Updateability Flag

FIG. 3

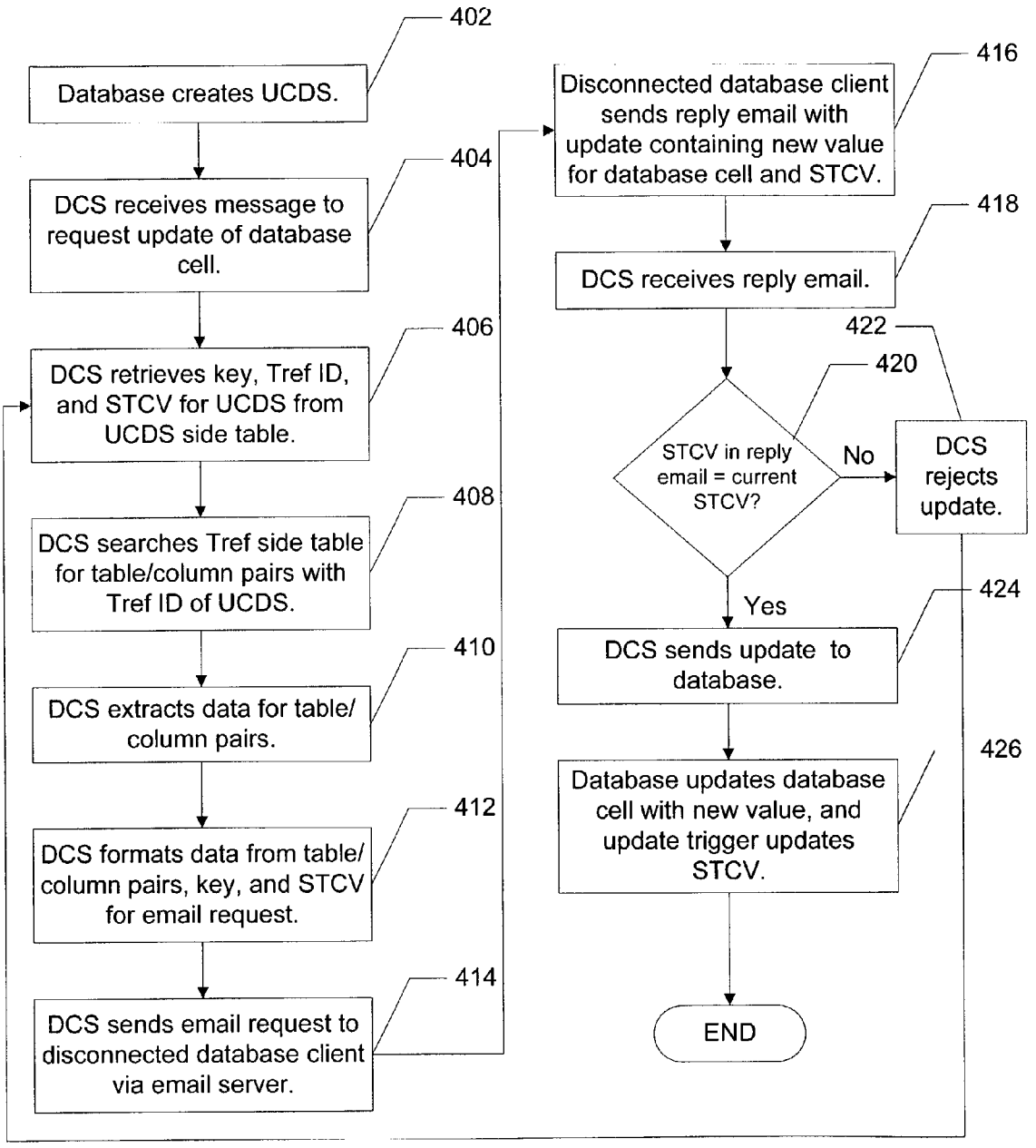

402
Database creates UCDS.
404
DCS receives message to request update of database cell.
406
DCS retrieves key, Tref ID, and STCV for UCDS from UCDS side table.
408
DCS searches Tref side table for table/column pairs with Tref ID of UCDS.
410
DCS extracts data for table/ column pairs.
412
DCS formats data from table/ column pairs, key, and STCV for email request.
414
DCS sends email request to disconnected database client via email server.
416
Disconnected database client sends reply email with update containing new value for database cell and STCV.
418
DCS receives reply email.
420
422
STCV in reply email = current STCV?
No
DCS rejects update.
Yes
424
DCS sends update to database.
426
Database updates database cell with new value, and update trigger updates STCV.
END

FIG. 4

REAL-TIME DATABASE UPDATE TRANSACTION WITH DISCONNECTED RELATIONAL DATABASE CLIENTS

FIELD OF THE INVENTION

The present invention relates to database systems, and more particularly to disconnected database clients of the database system.

BACKGROUND OF THE INVENTION

The updating of database cells by a client is known in the art. A "cell", as used in this specification, is a column/row intersection in a database table. For example, in the case of a remote or disconnected database client, to ensure reliability of updates, some conventional database systems either connect the remote client directly to the database system via a network or replicate the database, or a portion thereof, to create a local copy. If the client is connected directly to the database, the database locks the record containing the cell to be updated. The database rejects the client's update immediately if the database cell or its associated information is not valid or locked. However, many clients, such as cellular phones or personal digital assistants (PDAs), do not have the capability to connect directly to the database. Thus, this method is not an option.

If the database is replicated, the client updates a local copy of the database. At a later time, the client connects directly to the database system and the records from the updated copy are sent to the database. The database then either accepts or rejects the updates. However, many clients, such as cellular phones or PDAs, contain insufficient memory to store a local copy of the database. Thus, this method is not an option.

Accordingly, there exists a need for an improved method and system for performing real-time database update transactions with disconnected database clients. The method and system should ensure reliable updates without requiring the client to connect directly to the database or to replicate the database. The present invention addresses such a need.

SUMMARY OF THE INVENTION

A method and system for performing real-time database update transactions with disconnected database clients includes a disconnected client server (DCS) and disconnected client extensions (DCE). The DCS formats the database cell, its key, any associated database cells, and a timestamp and sends them to a disconnected database client by email. The timestamp indicates the last time the database cell or associated database cells was changed. The disconnected database client sends a reply email with the update of the database cell and the timestamp. Upon receipt of the reply email, the DCS compares the received timestamp to a current timestamp for the database cell. If they match, then the database cell is updated according to the received update. If they do not match, then the update is based on outdated information and is rejected. In this manner, reliable real-time update transactions are provided between a disconnected database client and the database.

BRIEF DESCRIPTION OF THE FIGURES

FIG. **1** illustrates a preferred embodiment of a system for performing real-time database update transactions with disconnected database clients in accordance with the present invention.

FIG. **2** is a flowchart illustrating a preferred embodiment of a method for performing real-time database update transactions with disconnected database clients in accordance with the present invention.

FIG. **3** illustrates in more detail an implementation of the side tables in accordance with the present invention.

FIG. **4** is a flowchart illustrating in more detail the preferred embodiment of the method for performing real-time database update transactions with disconnected database clients in accordance with the present invention.

DETAILED DESCRIPTION

The present invention provides an improved method and system for performing real-time database update transactions with disconnected database clients. The following description is presented to enable one of ordinary skill in the art to make and use the invention and is provided in the context of a patent application and its requirements. Various modifications to the preferred embodiment will be readily apparent to those skilled in the art and the generic principles herein may be applied to other embodiments. Thus, the present invention is not intended to be limited to the embodiment shown but is to be accorded the widest scope consistent with the principles and features described herein.

The method and system in accordance with the present invention utilizes a database client's ability to send and receive emails to perform real-time database update transactions. The system comprises a Disconnected Client Server (DCS) at a database server. The system further comprises Disconnected Client Extensions (DCE) and an Updateable Column Data Set (UCDS) at the database. In the preferred embodiment, the UCDS comprises the database cell to be updated and any associated database cells. The DCE comprises triggers, commands, and side tables for the management of the UCDS. The side tables comprise a synchro timestamp checksum values (STCV) for the UCDS. The DCS formats the UCDS database cells, the key of the UCDS, and the STCV and sends them to a disconnected database client by email. The STCV indicates the last time any of the UCDS database cells were changed. The disconnected database client sends a reply email with a new value for the database cell to be updated and the STCV. Upon receipt of the reply email, the DCS compares the received STCV to a current STCV for the UCDS. If they match, then the database cell is updated with the new value, utilizing the extensions in the DCE. If they do not match, then the database cell to be updated or its associated database cells has been changed since the update request was created. The update is thus based on outdated information and is rejected.

To more particularly describe the features of the present invention, please refer to FIGS. **1** through **4** in conjunction with the discussion below.

FIG. **1** illustrates a preferred embodiment of a system for performing real-time database update transactions with disconnected database clients in accordance with the present invention. The database system **106** comprises a database server **108** and a database **112**. A disconnected database client **102** can exchange emails via an email server **104** with the database server **108**.

The database **112** comprises the Disconnected Client Extensions (DCE) **114** and an Updateable Column Data Set (UCDS) **116**. In the preferred embodiment, the DCE **114** comprises a set of update, insert and delete triggers **132**, administration commands **134**, and side tables **136** that are used to manage the UCDS **116**. The UCDS **116** comprises one or more database cells **118** that will be updated and any

associated database cells **120** with data that the client **102** may require for determining the extent of an update to the database cell **118**. The side tables **136** of the DCE **114** comprises a set of references to the database cell **118** and a set of references to the associated database cells **120**, and a STCV **122** for the UCDS **116**. In the preferred embodiment, the STCV **122** comprises a timestamp indicating the last time the database cell **118** or its associated database cells **120** were changed and a checksum for error detection purposes. As the values in the UCDS **116** change, the STCV **122** is updated.

The database server **108** comprises a disconnected client server **110** (DCS). The DCS **110** is a conduit that takes the references in the side tables **136** for the UCDS **116** and retrieves the referenced database cell **118**, referenced associated database cells **120**, and the STCV **122** for the UCDS **116**. The DCS **110** formats the database cells **118** and **120** and the STCV **122** for an email request **124**. The email request **124** requests that the client **102** provide an update to the database cell **118**. The email request **124** thus comprises the UCDS **116** and its STCV **126**. At the time the email request **124** is created, the STCV **126** matches the STCV **122**. However, if either the database cell **118** or its associated database cells **120** subsequently changes, then the STCV **122** would also change. The STCV's **126** and **122** would then no longer match. The DCS **110** also receives a reply email **128** from the client **102**, comprising an update **130** containing a new value for the database cell **118** and the STCV **126** from the email request **124**.

FIG. **2** is a flowchart illustrating a preferred embodiment of a method for performing real-time database update transactions with disconnected database clients in accordance with the present invention. First, an update request **124** for a database cell **118** is sent from the database system **106** to a remote client **102** that is disconnected from the database system **106**, via step **202**. The update request **124** comprises the database cell **118** to be updated and a timestamp **126** for the database cell **118**. At the time the update request **124** is created, the timestamp **126** is the same as the timestamp **122**. In the preferred embodiment, the timestamp **122** also includes a checksum value for the corresponding database cell's current state, forming the STCV **122**.

Next, the database system **106** receives an update **130** and the timestamp **126** from the disconnected remote client **102**, via step **204**. The update **130** comprises a new value for the database cell **118**. The database system **106** then determines if the received timestamp **126** matches a current timestamp **122** for the database cell **118**, via step **206**. If they match, then the database cell **118** is updated according to the received update **130**, via step **208**. In the preferred embodiment, the database cell **118** is updated with the new value. Otherwise, the update **130** is rejected.

For an update transaction in accordance with the present invention, the database **112** creates the UCDS **116** and the side tables **136** using the triggers **132** and commands **134** of the DCE **114**. FIG. **3** illustrates in more detail an implementation of the side tables in accordance with the present invention. Assume that the database cell **118** comprise column U1 in the row identified by the key **304** in Table One **302**. Also assume that the associated database cells **120** comprise columns D2 and D3 in the row identified by the key **304** in Table Two **308**. Thus, columns U1, D2, and D3 comprise the UCDS **116** and have the same key **304**.

The DCE **114** creates a side table **314** for the UCDS **116**. The UCDS side table **314** comprises a UCDS record for the database cells **118** and **120**. The UCDS record for the UCDS **116** contains the key **304**, a unique Table Reference ID (Tref ID) **316** for the UCDS **116**, and a STCV **122** for the UCDS **116**. If more than one database cell is to be updated, then this database cell and its associated database cells would have a different key, such as Key **2**. The UCDS side table **314** thus defines the database cells that are part of the UCDS **116** and corresponds these cells with their key **304** and the STCV **122**.

References for each database cell in the UCDS **116** are also created in the side table **320** for the Tref ID **316**. Each reference contains the Tref ID **316**, a table name **322** and column name **324** pair, and an updateability flag **326**. For example, the reference for U1 contains the Tref ID **316**, "Table One" as the table name **322**, "1" as the column name **324**, and the updateability flag **326** is set since U1 is the database cell **118** to be updated. The reference for D2 contains the Tref ID **316**, "Table Two" as the table name **322**, "2" as the column name **324**, and the updateability flag **326** is unset since D2 is an associated database cell **120** and is not to be updated. The reference for D3 contains the Tref ID **316**, "Table Two" as the table name **322**, "3" as the column name **324**, and the updateability flag **326** is unset since D3 is an associated database cell **120** and is not to be updated.

In the preferred embodiment, the database **106** has one Tref side table **320** for all Table Reference ID's. The Tref side table **320** would thus contain the references for all of the UCDS's on the database **106**. Thus, the side table **320** can also contain references for a second UCDS with Tref ID **2**.

Although the side tables of the preferred embodiment is described above with the illustrated structure, one of ordinary skill in the art will understand that other table structures may be used without departing from the spirit and scope of the present invention.

FIG. **4** is a flowchart illustrating in more detail the preferred embodiment of the method for performing real-time database update transactions with disconnected database clients in accordance with the present invention. Referring to both FIGS. **3** and **4**, first, the database **112** creates the UCDS **116**, via step **402**, using the administration commands **134** of the DCE **114**. In the preferred embodiment, the UCDS **116** comprises the database cell **118** to be updated and its associated database cells **120**. Assume for example that database cell **118** is U1 and the associated database cells **120** are D2 and D3, illustrated in FIG. **3**. When the UCDS **116** is first created, the update, insert and delete triggers **132** are placed on each of the columns U1, D2, and D3. The administration command **134** creates the UCDS side table **314** and references for the UCDS **116** in the Tref side table **320**. The UCDS side table **314** contains a UCDS record, which comprises the key **304** for the database cells **118** and **120**, the unique Tref ID **316**, and the STCV **122** for the UCDS **116**. As a value in a UCDS column/key intersection changes, the update triggers on the columns will update the STCV **122** in the UCDS side table **314**.

Next, the DCS **110** receives a message to request an update of the database cell **118**, via step **404**. For example, the disconnected database client **102** may send the message to the DCS **110** that he/she wants to update a particular database cell. The DCS **110** then retrieves the key **304**, the Tref ID **316**, and the STCV **122** from the UCDS side table **314**, via step **406**. The DCS **110** searches the Tref side table **320** for the table/column pairs with the Tref ID **316**, via step **408**. The DCS **110** then extracts the data from the table/column pairs, via step **410**. In the illustrative example, the table/column pairs for the UCDS **116** is Table One/column **1** for U1; Table Two/column **2** for D2; and Table Two/column **3** for D3. The DCS **110** formats the data from the table/column pairs, the key **304**, and the STCV **126** for the

email request **124**, via step **412**. At this time, the STCV **126** in the email request **124** matches the STCV **122**. The key **304** identifies the row of the cell **118** in the table/column pair that is to be updated. The DCS **110** then sends the email request **124** to the client **102** via the email server **104**, via step **414**. The client **102** sends a reply email **128** with an update **130** containing a new value for the database cell **118** and the STCV **126**, via step **416**. The DCS **110** receives the reply email, via step **418**, via the email server **104**. The DCS **110** then determines if the STCV **126** in the reply email **128** matches the current STCV **122** of the UCDS **116**, via step **420**. If they match, then the DCS **110** sends the update **130** to the database **112**, via step **424**. The database **112** updates the cell **118** with the new value, and then the update trigger updates the STCV **122**, via step **426**. If the STCV **126** in the reply email **128** does not match the current STCV **122** of the UCDS **116**, then the DCS **110** rejects the update **130**, via step **422**. The DCS **110** then repeats steps **406** through **420**.

For example, assume that the method and system in accordance with the present invention are used by an office products service shop which has ten service representatives in the field. All of the service representatives have email enabled cellular phones. Assume also that the central office of the shop has a call dispatch system that is integrated into a database. A call information, such as customer name, address, and problem description is entered into the database **112** as a database record with an updateable cell **118** being an "Assigned To" field.

Assume that the database **112** creates an UCDS **116** with this database cell **118**, via step **402**. The UCDS **116** comprises the database cell **118** that contains the "Assigned To" field and any associated database cells **120** the service representatives need to perform an update. The DCS **110** receives a message to request the update of the database cell **118** from each of the ten service representatives in the field, via step **404**. The DCS **110** then retrieves the key **304**, the Tref ID **316**, and the STCV **122** of the UCDS **116** from the UCDS side table **314**, via step **406**. The DCS **110** formats the email requests **124** to the service representatives, via steps **408–412**. At this time, the STCV's **126** in the email requests **124** match the STCV **122**. The DCS **110** sends the email requests **124** to the cellular phones of each of the ten service representatives, via step **414**.

The service representatives receive their respective email requests. Assume that a first service representative sends a reply email **128** with an update **130**, via step **416**. The reply email **128** also comprises the STCV **126**.

The DCS **110** receives the reply email **128** from the first service representative, via step **418**. Assume that the DCS **110** determines that the STCV **126** in the reply email **128** matches the current STCV **122** of the UCDS **116**, via step **420**. The DCS **110** then sends the update **130** of the database cell **118** to the database **112**, via step **424**. The database **112** uses the update trigger on the database cell's column to update the database cell **118** and the STCV **122**, via step **426**.

Assume that a second service representative sends a reply email **128**, via step **416**, after the database cell **118** has been updated by the first service representative. The DCS **110** receives the reply email **128**, via step **418**. Since the STCV **122** has been changed by the first service representative's update, the DCE **110** determines that the STCV **126** in the second service representative's reply email **128** do not match the current STCV **122**, via step **420**. The DCS **110** then rejects the update **130** from the second service representative, via step **422**. The DCS **110** then retrieves the current key **304**, Tref ID **316**, and the current STCV **122** from the UCDS side table **314**, via step **406**. The DCS **110** repeats steps **408–412** and sends a second email request **124** to the second service representative, via step **414**. The second email request **124** comprises the database cell **118** updated by the first service representative and an updated STCV **126**. The updates STCV **126** is the same as the STCV **122** at the time the second email request **124** was created.

The second service representative receives the second email request **124** and sends a second reply email with a new update **130** and the STCV **126**, based on the database cell **118** and associated database cells **120** as updated by the first service representative, via step **416**. The DCS **110** receives the second reply email **128**, via step **418**. Assume that no further updates of the database cell **118** or its associated database cells **120** has occurred since the second email request **124** was created. The DCE **110** thus determines that the STCV **126** in the second reply email **128** matches the current STCV **122** of the UCDS **116**, via step **420**. The DCS **110** sends the new update **130** from the second service representative to the database **112**, via step **424**. The database **112** uses the update trigger of the database cell's column to update the database cell **118** and the STCV **122**, via step **426**.

Although the present invention has been described with one UCDS, one of ordinary skill in the art will understand that more than one UCDS, each with its own side table, can be used without departing from the spirit and scope of the present invention.

Although the present invention has been described in the context of emails, one of ordinary skill in the art will understand that anything which can package data and transmit data between a sender and a receiver, without the sender being directly connected to the receiving system, or the receiver being directly connected to the sending system, may be used without departing from the spirit and scope of the present invention.

An improved method and system for performing real-time database update transactions with disconnected database clients have been disclosed. The system comprises a DCS at the database server and DCE and a UCDS at the database. The DCS formats the database cell to be updated, its key, any associated database cells, and a timestamp and sends them to a disconnected database client by email. The timestamp indicates the last time the database cell or its associated database cells was changed. The disconnected database client sends a reply email with the update of the database cell and the timestamp. Upon receipt of the reply email, the DCS compares the received timestamp to a current timestamp for the database cell. If they match, then the database cell is updated according to the received update. If they do not match, then the database cell or its associated database cells has been changed since the update request was created. The update is thus based on outdated information and is rejected. In this manner, reliable real-time update transactions are provided between a disconnected database client and the database.

Although the present invention has been described in accordance with the embodiments shown, one of ordinary skill in the art will readily recognize that there could be variations to the embodiments and those variations would be within the spirit and scope of the present invention. Accordingly, many modifications may be made by one of ordinary skill in the art without departing from the spirit and scope of the appended claims.

What is claimed is:

1. A method for performing real-time update transactions between a database and disconnected database clients, comprising the steps of:

(a) sending an update request for a data from a database system to a client, wherein the client is disconnected from the database system, wherein the update request comprises:

an updatable column data set (UCDS), wherein the UCDS comprises:

a database cell, and

associated database cells,

a synchro timestamp checksum value (STCV), wherein the STCV comprises:

a timestamp, wherein the timestamp indicates a last time the database cell or the associated database cells was changed, and

a checksum for the database cell, and

a key for the UCDS,

wherein the sending step (a) comprises:

(a1) creating the UCDS and the STCV by the database, wherein the creating step (a1) comprises:

(a1i) creating a first side table comprising a UCDS record, the UCDS record comprising the key, a Table Reference ID (Tref ID) for the UCDS, and the STCV, and

(a1ii) creating a plurality of references in a second side table, wherein each reference comprises the Tref ID, a table name of the database cell or the associated database cell, a column of the database cell or the associated database cell, and an updateability flag,

(a2) receiving by a disconnected client server (DCS) a message to request an update of the database cell,

(a3) retrieving the database cell and the associated database cells of the UCDS, the key, and the STCV from the database,

(a4) formatting the database cell and the associated database cells, the key, and the STCV for an email request by the DCS, and

(a5) sending the email request to the disconnected database client;

(b) receiving an update and the timestamp for the data from the disconnected database client;

(c) determining if the received timestamp matches the current timestamp for the data; and

(d) updating the data according to the received update, if the timestamp of the received update matches the current timestamp for the data.

2. The method of claim **1**, wherein the retrieving step (a3) comprises:

(a3i) retrieving the key, the Tref ID, and the STCV from the UCDS record in the first side table;

(a3ii) searching the second side table for table name/column pairs with the Tref ID;

(a3iii) extracting the database cell and the associated database cells using the table name/column pairs.

3. A computer readable medium with program instructions for performing real-time update transactions between a database and disconnected database clients, comprising the steps of:

(a) sending an update request for a data from a database system to a client, wherein the client is disconnected from the database system, wherein the update request comprises:

an updatable column data set (UCDS), wherein the UCDS comprises:

a database cell, and

associated database cells,

a synchro timestamp checksum value (STCV), wherein the STCV comprises:

a timestamp, wherein the timestamp indicates a last time the database cell or the associated database cells was changed, and

a checksum for the database cell, and

a key for the UCDS, wherein the sending step (a) comprises:

(a1) creating the UCDS and the STCV by the database, wherein the creating instruction (a1) comprises:

(a1i) creating a first side table comprising a UCDS record, the UCDS record comprising the key, a Table Reference ID (Tref ID) for the UCDS, and the STCV, and

(a1ii) creating a plurality of references in a second side table, wherein each reference comprises the Tref ID, a table name of the database cell or the associated database cell, a column name of the database cell or the associated database cell, and an updateability flag,

(a2) receiving by a disconnected client server (DCS) a message to request an update of the database cell,

(a3) retrieving the database cell and the associated database cells of the UCDS, the key, and the STCV from the database,

(a4) formatting the database cell and the associated database cells, the key, and the STCV for an email request by the DCS, and

(a5) sending the email request to the disconnected database client;

(b) receiving an update and the timestamp for the data from the disconnected database client;

(c) determining if the received timestamp matches the current timestamp for the data; and

(d) updating the data according to the received update, if the timestamp of the received update matches the current timestamp for the data.

4. The medium of claim **3**, wherein the retrieving instruction (a3) comprises:

(a3i) retrieving the key, the Tref ID, and the STCV from the UCDS record in the first side table;

(a3ii) searching the second side table for table name/column name pairs with the Tref ID;

(a3iii) extracting the database cell and the associated database cells using the table name/column pairs.

5. A system, comprising:

a database, comprising disconnected client extensions (DCE), wherein the database utilizes the DCE:

to create an UCDS comprising a data,

to create a timestamp for the UCDS, wherein the timestamp indicates the last time the data was changed, and

to update the data and the timestamp when an update is received from a database server; and

the database server, comprising a disconnected client server (DCS), wherein the DCS sends an update request comprising the data and the timestamp to a client, wherein the client is disconnected from the database server, wherein the DCS receives the update and the timestamp of the update request from the disconnected database client,

wherein the DCS sends the received update to the database if the received timestamp matches the current timestamp for the UCDS, wherein the data is updated by the database according to the update, wherein the client is disconnected from the database during the update;

wherein the DCE comprises:

a first side table comprising a UCDS record, the UCDS record comprising:

a key for the UCDS record, defining a database cell,

a Tref ID of the UCDS record, and

the timestamp for the UCDS record;

a second side table, comprising a reference for the database cell, comprising:

the Tref ID,

a table name of the database cell,

a column name of the database cell, and

an updateability flag;

commands for creating the first and second side tables; and

triggers for managing the first and second side tables and the database cell.

6. The system of claim **5**, wherein the triggers update the database cell and the timestamp.

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